

field, contained a similar quantity of nitrate to that found in the exhausted soil around the plant at the end of the season. The next year he finds that the soil of the field, when deprived of vegetation, doubled its contents in nitrates between June 4 and "the end of the season"; but this rate of increase was insufficient to account for the nitrates found in the crop the *previous year*! Finally, to prove that the plant contains a nitrifying agent, a single experiment is made by introducing a fragment of the stem of *Amaranthus* into a flask containing 300 grams of sterilised and exhausted soil. At the end of eleven weeks six milligrams of saltpetre were found in the soil. A blank experiment, made with soil only, was for some reason only continued for six weeks.

Data such as these are quite insufficient to convince a critical reader. Our confidence in the investigation is not increased by reading that the growth of a *single* crop in the field diminished the nitrogen in the soil from '275 to '173 per cent., and the potash of the soil in the neighbourhood of the roots from '64 to '47 per cent. Nor by remarking that the same figures for nitrates in the soil are first quoted as kilograms, and are afterwards always spoken of as grams.

The whole of the first volume is occupied with an account of investigations on the fixation of atmospheric nitrogen by soil and plants. M. Berthelot has been a pioneer in this branch of inquiry. The peculiar function of the organism forming the nodules on the roots of leguminous plants is now universally recognised. A similar case of symbiosis between a nitrogen-assimilating organism and certain algæ is also well known. Not so well known is the isolation of a bacillus from the soil by Winogradsky, which when supplied with sugar, and protected from the action of oxygen, is capable of assimilating atmospheric nitrogen. This organism succeeds in assimilating nitrogen from ordinary air when it is associated with ærobic organisms which appropriate the oxygen, and thus produce conditions suitable for the growth of the bacillus assimilating nitrogen.

Both in the case of the reaction in the leguminous rootlets and algæ, and in the case of the reaction *in vitro*, studied by Winogradsky, we have a clear indication of the source of the chemical energy which accomplishes the difficult task of bringing nitrogen into a state of organic combination; in every case we have carbohydrates abundantly present, and in Winogradsky's experiments we have a demonstration that the quantity of sugar fermented is a measure of the quantity of gaseous nitrogen assimilated.

With this principle before us we should suppose that a soil entirely destitute of vegetation could fix nitrogen only at the expense of its own organic matter; carbon would, in fact, be lost in the operation of fixing nitrogen. If, on the other hand, certain green algæ or leguminous plants were present, fixation of nitrogen might be accompanied by an actual gain of organic matter.

According to Berthelot's experiments, soils destitute of visible vegetation may gain large quantities of nitrogen when exposed to air. Even subsoils of argillaceous sand or clay, containing mere traces of carbon or nitrogen, are capable of gaining considerably in nitrogen when exposed to air. From an agricultural point of view, the quantities of nitrogen fixed are very considerable. Layers,

7 inches deep, of three surface soils from Meudon, fixed in 11 weeks from 70 lbs. to 130 lbs. of nitrogen per acre, quantities equivalent to 6-11 tons of farmyard manure. If this enrichment of soil by mere exposure to air is a fact, we shall be very anxious to know what are the precise conditions and limitations of such a beneficial action. Scientific agriculturists will be loath to admit that the exposure of a soil uncovered by vegetation tends to its permanent enrichment; the process of weathering tends, on the contrary, to the exhaustion of soil capital, and not to an increase of nitrogenous organic matter.

Berthelot's trials of various organisms yielded results of a similar favourable character. Out of seven organisms tried five produced an active fixation of nitrogen. The composition of the medium was apparently indifferent, for a mixture of certain bacilli from soil with kaolin determined an increase of 32 per cent. of the original nitrogen in one case, and an increase of 150 per cent. in another. Among the organisms fixing nitrogen, Berthelot includes the common mould *Aspergillus niger*.

In the last section of this volume Berthelot describes experiments which lead him to the conclusion that the natural electrical conditions, both of soil and plant, aid in bringing about the fixation of nitrogen from the air.

It is to be regretted that the large amount of work contained in these volumes is not of a more thorough and definite character, but we are very thankful that the investigations have been published. R. W.

OUR BOOK SHELF.

Bird Life in an Arctic Spring; the Diaries of Dan Meinertzhagen and R. P. Hornby. Edited by Mrs. G. Meinertzhagen. Pp. iii + 150. Illustrated. (London: Porter, 1899.)

A PATHETIC interest attaches to this volume, as being practically a memorial to a most promising and talented young ornithologist, whose life was unhappily cut short almost at the outset of his career. The late Mr. D. Meinertzhagen was essentially a lover of bird-life, and thus a naturalist in the very best sense of that somewhat abused word. But he was much more than this, being an artist of great talent, whose sketches and etchings of birds form some of the most beautiful delineations of feathered life it has been our fortune to see. In addition to those illustrating the text itself, nearly thirty of these talented sketches have been photographically reproduced as an appendix to the present volume, and serve not only to enhance the general interest of the latter, but likewise to convey an excellent idea of the artistic capacity of the author of the journal which constitutes its main claim to attention.

As we gather from the preface, the book is mainly intended for private circulation, and only a limited number of copies are offered to the general public. On the whole, the editor has exercised a wise discretion in endeavouring to preserve the journal of her son as much as possible in its original form, although it must be confessed that a little fuller supervision on the part of a trained ornithologist than has been permitted would have been advantageous in a few instances.

The journal is divided into two portions, the first and longer by Mr. Meinertzhagen, and the second by his companion Mr. Hornby. The trip to Lapland, of which these form the chronicle, was undertaken in 1897; and the journal of the originator breathes out the enthusiasm of an ardent bird-lover. The two companions appear to have visited spots to which few if any Englishmen

have penetrated since Wolley's time; and in collecting eggs they suffered almost from *embarrass des richesses* on account of the numbers that were brought in by the natives. One of the objects of their desire was to obtain a clutch of Smew's eggs, but it was not an easy matter to identify these without some of the down from the nest. At length they succeeded in obtaining what they thought were the right eggs; and their acumen was confirmed on arrival in England by the identification of the specimens from the down.

A section of the volume is also devoted to an account of the magnificent collection of raptorial birds maintained by the late author of the first journal at his father's seat, Mottisfont Abbey, Romsey. This collection, which is stated to be one of the finest in England, is still maintained; and the account shows how it is possible to keep such splendid birds in perfect condition. Altogether, the bird-lover will find much to interest him in this charming little volume.

R. L.

Progressive Lessons in Science. By A. Abbott, M.A., and Arthur Key, M.A. Pp. xix + 320. (London: Blackie and Son, Ltd., 1899.)

THIS book consists of two parts—the first, by Mr. Abbott, dealing with the non-metallic elements found in animal and vegetable substances; the second, by Mr. Key, on the detection and distribution of the elements in animal, vegetable and mineral substances. The former part contains a course of experimental work in chemistry of a kind with which many text-books have made us familiar. All that need be said of it is that most of the experiments are suitable for performance in the laboratory by beginners in chemistry, and that the book will assist the progress of rational methods of science teaching. With regard to the second part, though the plan has something to commend it, the execution is open to criticism. Mr. T. G. Rooper, who generously endeavours to assist the volume by his introduction, remarks upon the idea to which we refer. "The most original feature in the book is the set of experiments which illustrate the composition of food-stuffs. Starting with a table of the chief constituents of the blood, the author proves the presence of each by the use of an ingeniously-devised test. He then traces each constituent through animal life to the vegetable life on which animal life is supported, and thence to the soil from which the plant derives it, and finally to the rock, by the disintegration of which the soil is formed." There are several grave objections to this method of procedure as it is here presented. Students are told the tests which have to be applied to detect different substances, hence the experiments are not in advance of the test-tube practice which is fast giving place to more intelligent practical instruction. Moreover, the object of the experiments is too complicated to be of real educational value to beginners; and, finally, very few students have the time to do so much experimental work. Originality in text-books is a very commendable characteristic, but the authors should know that practicability is an even more important factor to consider. In its present form the book may be of service to a few teachers of domestic science and hygiene, but we do not think any other useful purpose will be served by its publication.

De la Méthode dans la Psychologie des Sentiments. By F. Rauh. Pp. 305. (Paris: Félix Alcan, 1899.)

THIS is a valuable monograph the merit of which is unfortunately partly concealed by a singularly obscure and unattractive literary style. M. Rauh's principal object is to enter a warning against the growing tendency of psychologists to neglect the adequate description of complicated facts, and to corrupt their science in its infancy by excessive reliance upon over-simple metaphysical and psychophysical theories. Psychology, as he well points out, possesses as yet no such simple and universal generalisation as that of the conservation of energy; in

the present state of the science any single theoretical generalisation is premature; for the full description of the facts of mental life we need many points of view, each represented by a different tentative hypothesis. Thus the emotions, which form the immediate subject of the essay, may be studied as concomitants of physiological changes in the organism, as embodying a *quasi*-judgment on the part of the organism as to what is beneficial or harmful, as manifestations of the "will to live," or finally as special phenomena calling for independent description and classification. Each of these points of view throws light upon some characteristic of human emotions, and none of them can be neglected in a complete psychology of sentiment. In the course of the argument many one-sided theories, especially that of Prof. James as to the organic concomitants of emotion, receive really trenchant criticism. Like most French writers, M. Rauh is particularly happy in what may be called "psychological diagnosis"; his too rare descriptions of the various emotional "temperaments" are subtle and illuminating. On the other hand, he makes occasional slips which partly vitiate his reasoning. In his deductions from the supposed existence of special "pain-conducting" nerves, for instance, he forgets to allow for the possibility that what the nerve conducts is the special presentative element, the "racking," "stabbing," or "burning" sensation rather than the painfulness of it. Again, he scarcely lays enough stress on the fact that our emotional state at any moment depends, not on isolated sensations, but upon the total complex of our sensations at the moment. And, finally, to the present writer at least, the conception of "psychical forces," of which M. Rauh makes great use, is exceedingly obscure. It is a pity that terminology, which has led to so many confusions, even in dynamics, should be needlessly transported into psychology.

A. E. T.

Histoire Abrégée de l'Astronomie. Par Ernest Lebon. Pp. vii + 288. (Paris: Gauthier-Villars, 1899.)

THIS book, as its title implies, is not intended as a complete history of the progress of astronomical science from the earliest day, but is devoted to rendering a brief account of the main steps in this progress, and at the same time giving us short biographical sketches of the chief workers in this branch of science. The subject is divided into three parts. The first deals with the ancient period which ends in the middle of the sixteenth century: only eighteen pages are devoted to this portion, so that the reader can rightly conclude that only a very general sketch has been attempted. The second or modern period, extending to the middle of the nineteenth century, commences with the system of Copernicus, and ends with an account of the state of the science at the time of the death of the illustrious astronomer of the Königsberg Observatory, Friedrich-Wilhelm Bessel. The last, or contemporary, period is contained in 125 pages. M. Lebon divides this portion of the book into ten chapters, dealing in each with the progress made in separate branches of the subject. Thus we find first an account of the advance made in celestial mechanics, then the progress in observational astronomy, spectroscopy, geodesy, photography, &c. Each of these reviews is brought well up to date, and contains a good general survey of the progress made. A useful addition to the book will be found in the biographical and bibliographical dictionary which follows this last portion. Besides a small chart of the northern hemisphere, which apparently has little utility in such a book as this, the illustrations include a set of sixteen processed reproductions of portraits of celebrated astronomers. Not only should astronomical readers find this book a welcome addition to their libraries, but those interested in the welfare of this, the oldest, of sciences, will peruse these pages with advantage.